US007793479B2

(12) **United States Patent**
Kelly

(10) **Patent No.: US 7,793,479 B2**
(45) **Date of Patent: Sep. 14, 2010**

(54) **ROOF STRUCTURE AND METHOD FOR MAKING THE SAME**

(76) Inventor: **Thomas L. Kelly**, 31 Sands St., Waterbury, CT (US) 06710

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 604 days.

(21) Appl. No.: **11/693,224**

(22) Filed: **Mar. 29, 2007**

(65) **Prior Publication Data**

US 2007/0193157 A1 Aug. 23, 2007

Related U.S. Application Data

(63) Continuation-in-part of application No. 10/889,940, filed on Jul. 13, 2004, now Pat. No. 7,493,733.

(51) **Int. Cl.**
E04B 7/00 (2006.01)

(52) **U.S. Cl.** **52/409**; 52/309.4; 52/309.7; 52/746.11

(58) **Field of Classification Search** 52/309.7, 52/309.4, 309.6, 309.8, 408, 409, 411, 404.1, 52/746.11, 746.1, 745.06, 741.1
See application file for complete search history.

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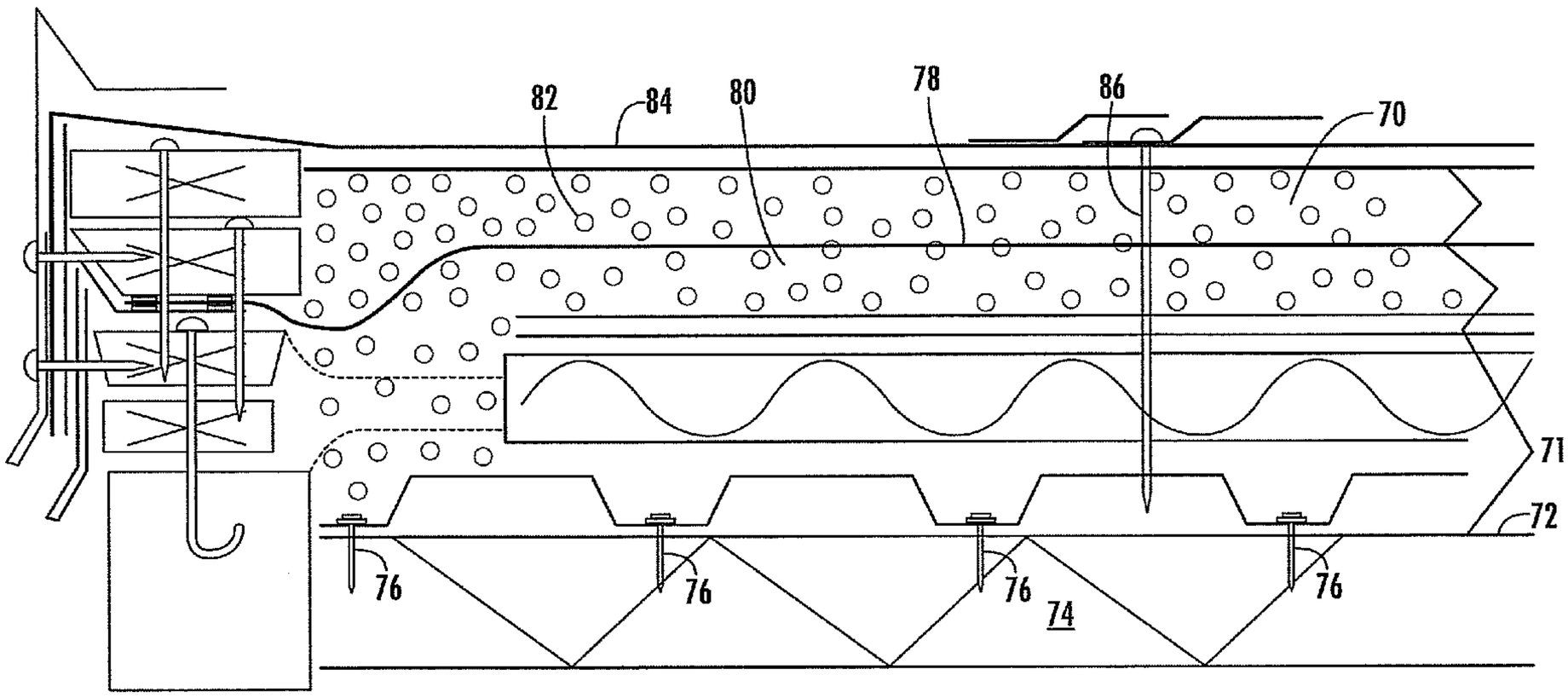
Primary Examiner—Brian E Glessner
Assistant Examiner—Adriana Figueroa
(74) *Attorney, Agent, or Firm*—Cantor Colburn LLP

(57) **ABSTRACT**

Disclosed herein is a roof system including a roof deck, a previously existing roofing assembly upwardly adjacent to the roof deck, a foam material upwardly adjacent and in air sealing contact with the roofing assembly, a layer of reinforcing mesh embedded in the foam material, and a waterproof membrane upwardly adjacent of the foam material.

4 Claims, 5 Drawing Sheets



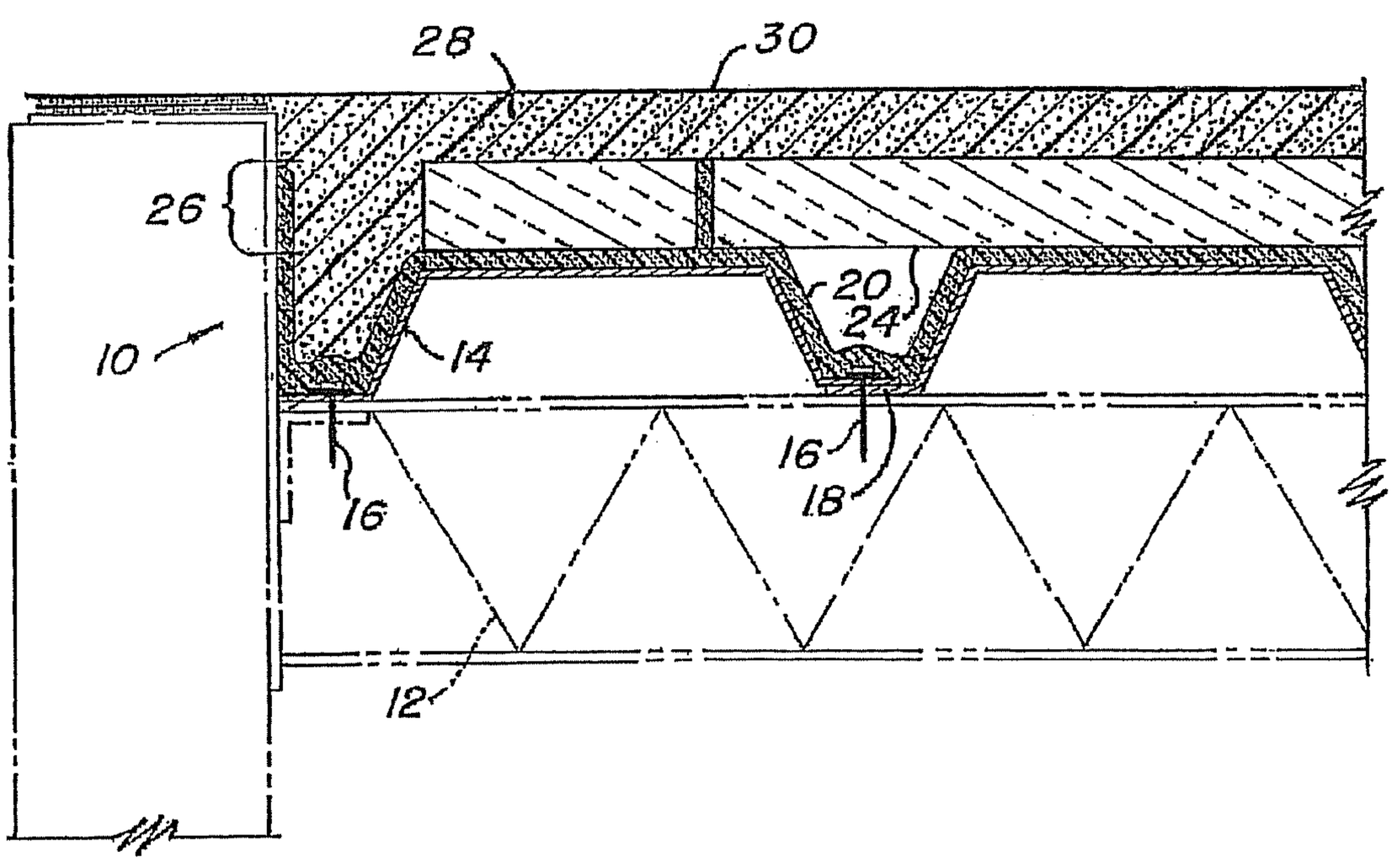


FIG. 1

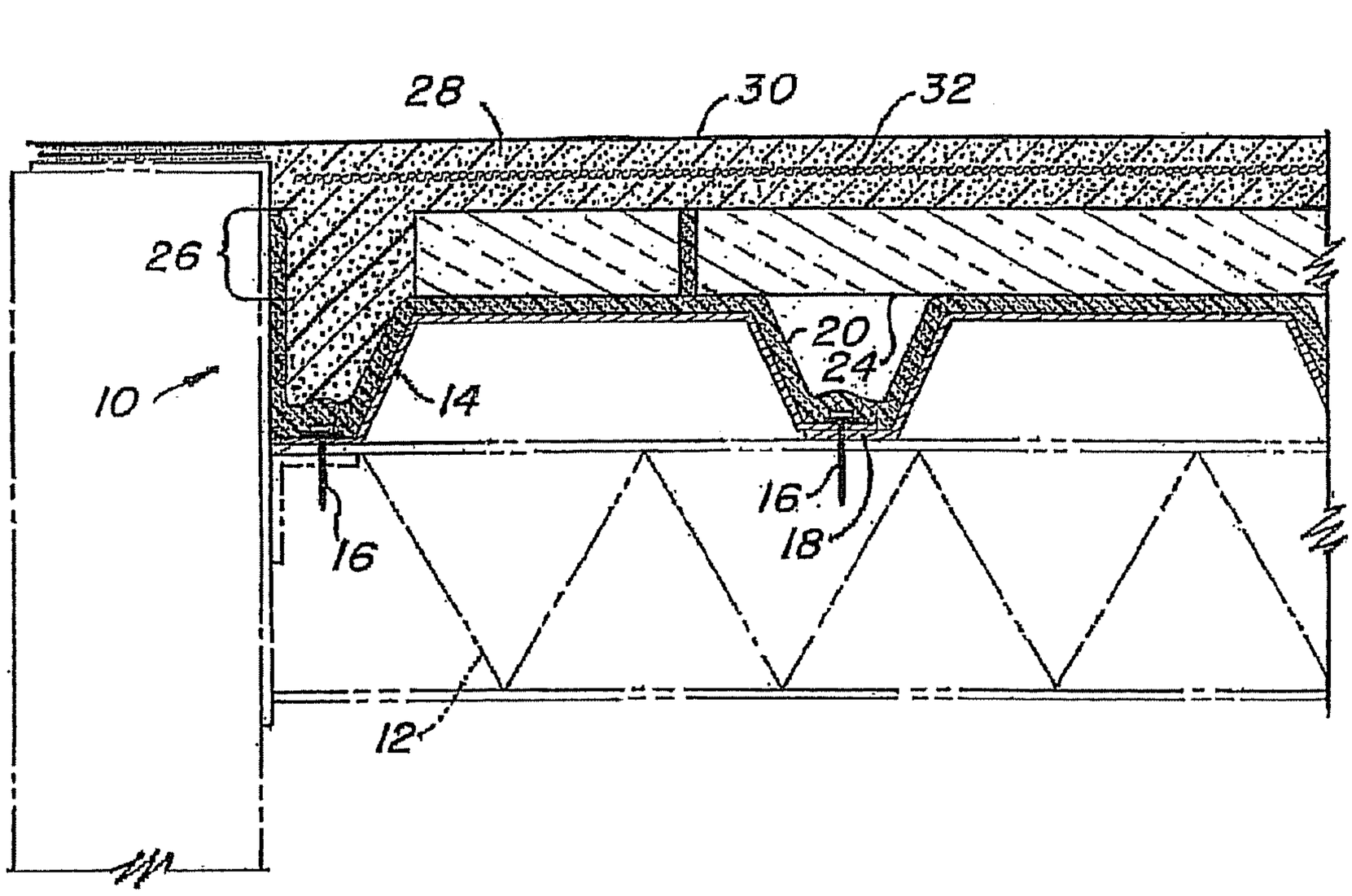


FIG. 2

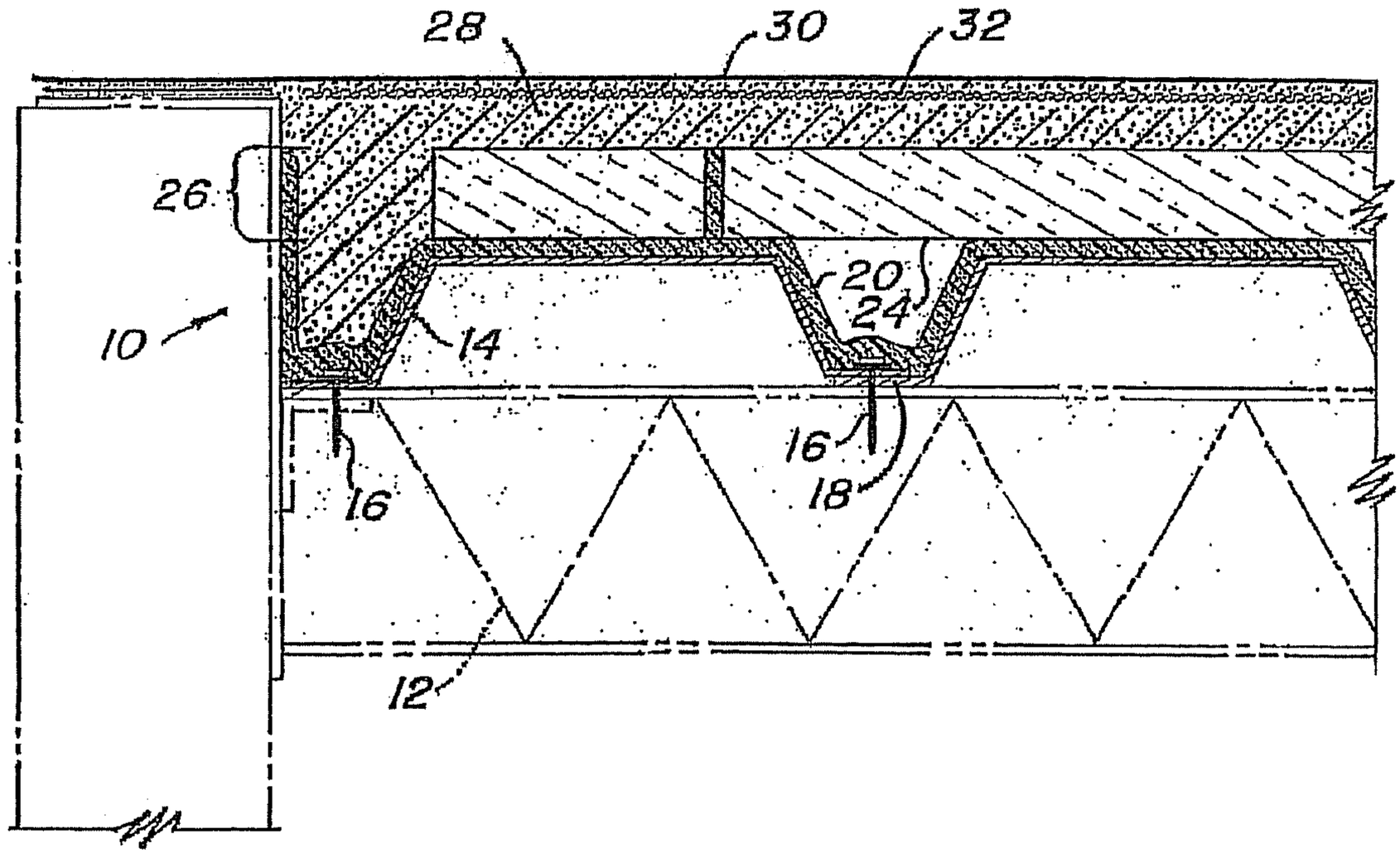


FIG. 3

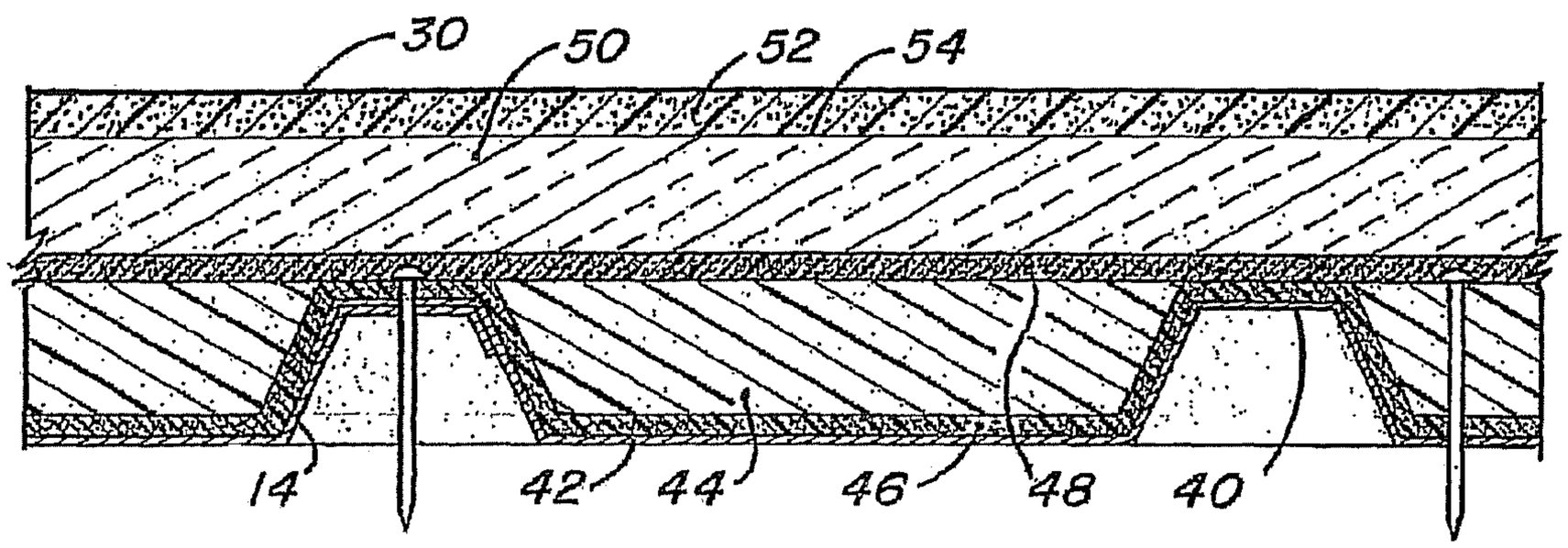


FIG. 4

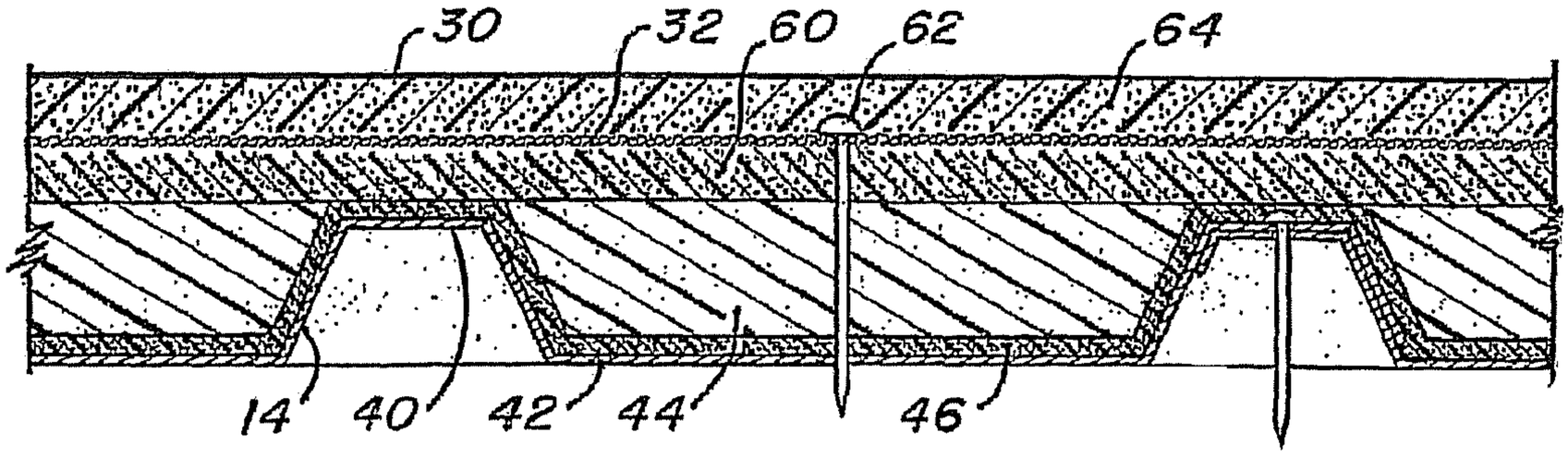


FIG. 5

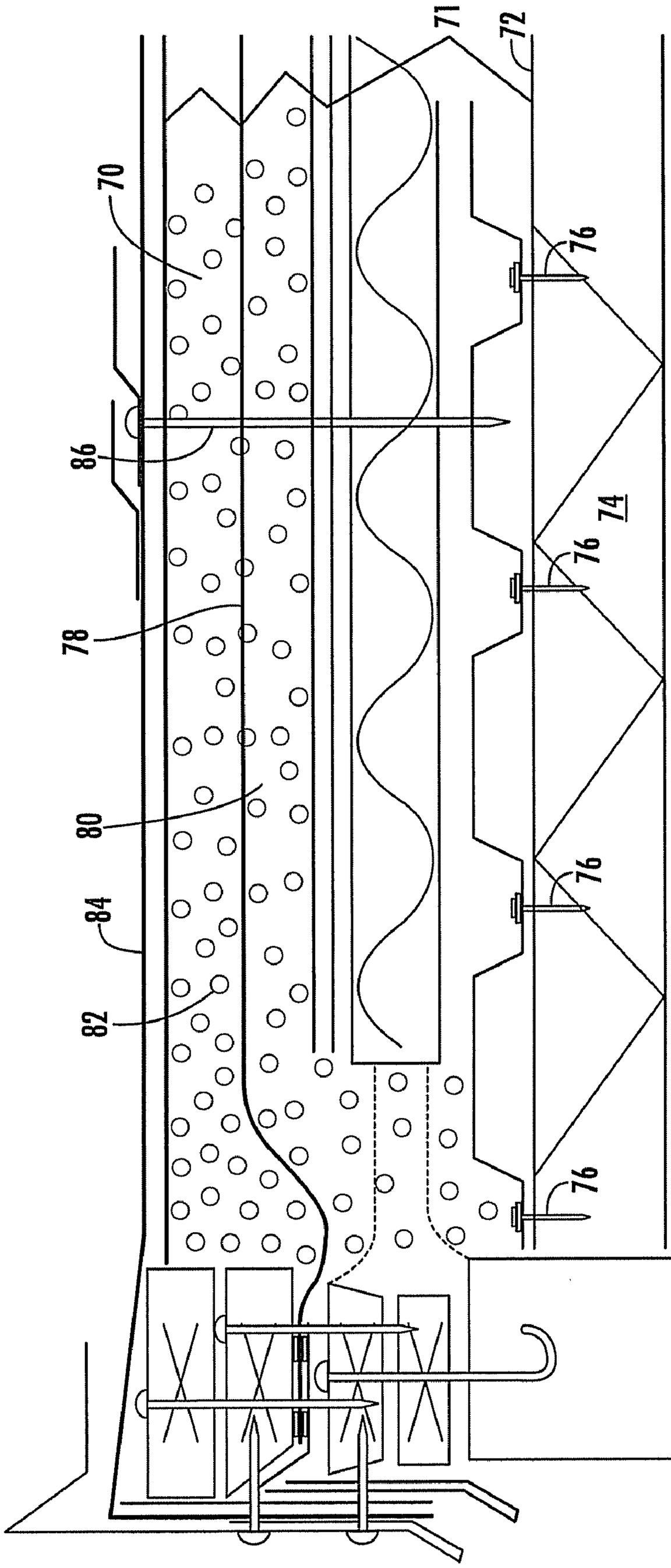


FIG. 6

ROOF STRUCTURE AND METHOD FOR MAKING THE SAME

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part that claims benefit of priority under 35 U.S.C. §120 to U.S. application Ser. No. 10/889,940 filed on Jul. 13, 2004, the entirety of which is hereby incorporated by reference.

BACKGROUND

Roof structures have been made for millennia ranging from simple lean-to thatched arrangements to more modem buildings having multiple layers of roofing materials, fire barriers, vapor barriers, air retarders, rigid roof insulations, cover boards, slipsheets and waterproofing membranes all designed to work together to keep the elements away from occupants of the building. Roof structures continue to be improved because each of the systems currently available has drawbacks and improvements are therefore desirable. Typical problems with roof structures center around wind uplift resistance and energy efficiency with insulations for heat and cold resistance to maintain internal building temperature as well as time and effort required to install the roof system.

SUMMARY

Disclosed herein is a roof system including a roof deck, a previously existing roofing assembly upwardly adjacent to the roof deck, a foam material upwardly adjacent and in air sealing contact with the roofing assembly, a layer of reinforcing mesh embedded in the foam material, and a waterproof membrane upwardly adjacent of the foam material.

Also disclosed is a method for creating a roof system comprising:

air sealing a previously existing roofing assembly with a foam material and embedding a reinforcing mesh within the foam material.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings wherein like elements are numbered alike in the several Figures:

FIG. **1** is a cross-sectional elevation view of the subject roof system;

FIG. **2** is a cross-sectional elevation view of the similar roof system to that of FIG. **1** however including a reinforcing mesh in a first position;

FIG. **3** is a cross-sectional elevation view of another alternate embodiment roof system with the reinforcing mesh in a second position;

FIG. **4** is a cross-sectional elevation view of a roof system intended for a metal building;

FIG. **5** is a cross-sectional elevation view of a roof system similar to that of FIG. **4** and the reinforcing material applied thereto; and

FIG. **6** is a cross-sectional elevation of a roof system built upon an existing roof assembly.

DETAILED DESCRIPTION

Referring to FIG. **1** an embodiment of the roof system **10** as disclosed and claimed herein is supported by an underlying building having joists or purlins **12**. The roof deck **14** which may be a metal corrugated roof decking material is fastened to

the underlying support structure **12** by conventional means such as fasteners **16**. As corrugated metal decking **14** or any other modular decking material has a certain size and shape it is clear that there will be joints or overlap sections of the material. In FIG. **1** there is an overlap section identified as an overlap flute area **18**. Such overlap flute areas present an opportunity for easy entry of air from the building being roofed if such flutes are not sealed. Abutting edges of plywood or other material roofs create the same problem and can be resolved in the same manner as discussed hereunder.

In the embodiment of FIG. **1**, the roof decking material **14** is thinly but relatively uniformly covered by a foam **20** which may be a polyurethane foam or polyurea compound or other material having similar properties and combinations of materials including at least one of the foregoing materials and may be a slow curing foam or a fast curing foam depending upon functionality desired by the installer. As illustrated in FIG. **1**, foam **20** is a slow rise, slow cure polyurethane type foam which is desirable in this case because it allows adherence of the insulation board **24** to the uncured newly sprayed foam **20**. During application of the foam **20** an installer will, in accordance with this disclosure, pay particular attention to covering overlap flutes **18** and any fastener **16** or other penetrations through the roof deck **14**. The purpose of such concentration is to ensure that deck **14** is sealed against air movement therethrough. Following application of the foam **20**, a plurality of insulation boards **24** are applied to the uncured foam **20** to be adhered thereto without the use of any mechanical fasteners which might otherwise provide a thermal bridge through the insulation layer. Also notable is that this disclosure teaches one of ordinary skill in the art to place in the insulation layer **24** spaced from a through roof penetration or roof perimeter location creating a space **26** that will subsequently be filled with foam to create a positive air seal and the thickness of the foam also acting as insulation. Following the application of the insulation layer **24** another layer of foam **28** is applied over the insulation layer and around the insulation layer at penetrations or a roof perimeter location. This material may be fast or slow rise material but in general fast rise material will be utilized at this stage of the roof construction since it cures rapidly and allows workers to walk thereon very quickly. Since there is no need to adhere any roof components to this foam material prior to the curing of material **28** there is no need to use slow rise foam. In general about an inch of foam is applied above the insulation boards **24** to provide a uniform top surface having a horizontal or inclined property as desired.

At this point in the creation of the roof system, this roof will be waterproof and may act as a temporary roofing system prior to insulation of the waterproofing membrane which will be the permanent roof waterproofing component. This is beneficial in that workers may utilize the roof for walking without damaging the relatively fragile waterproofing membrane that will be installed later. One example of a membrane is EPDM. The membrane may be installed over the foam **28** in any of a number of conventional methods. The membrane is identified in FIG. **1** as numeral **30**.

Referring now to FIG. **2**, it will be appreciated by one of ordinary skill in the art that the roof of FIG. **2** very similar to that of FIG. **1**; the distinction between the two figures is that an additional reinforcing layer **32** is embedded about halfway between insulation layer **24** and the ultimate top surface of material **28**. In one embodiment the reinforcing material **32** is installed in this location by applying less foam **28** over the insulation board **24** such as for example about a half inch of spray foam locating reinforcement material **32** openly adjacent to a half inch sprayed foam and then spraying an addi-

tional half inch of foam thereover. It will be understood that the thicknesses of foam indicated herein are only intended for relative purposes and are not intended to be limiting with respect to how thick or how thin the foam is ultimately applied.

The reinforcing material **32** is in one embodiment a mesh material which may comprise fiberglass, nylon, polyester, or other material having similar properties with respect to the purpose for which the reinforcing material **32** is added to the roof system of FIG. **2**. That is that the material will add tensile strength, rigidity, transverse strength, etc. to the roof system. The reinforcement, if fiberglass, adds fire protection for polystyrene rigid roof insulations from exterior fire sources. Referring now to FIG. **3** one of ordinary skill in the art will again recognize that much of the figure is similar to the foregoing figures with places the reinforcing material **32** very near or at the top surface of foam **28**. The reinforcing material may be installed in this position by locating material **32** at the top surface of foam **28** prior to curing thereof and may then be sprayed over or urged into foam **28**. It is noted that in some applications it may be desirable to utilize slow rising foam in place of faster rising foam **28** for purposes of increasing adherence between the foam layer and the reinforcing material **32**. With respect to both FIGS. **2** and **3** the waterproofing membrane **30** is installed as was indicated with respect to FIG. **1**.

Referring now to FIG. **4** this roofing system could be applied to an existing metal building that did not employ an insulated type roofing system when originally manufactured or built but rather simply utilized the metal deck **14** as the roof system. This disclosed roofing system could also be utilized on a new metal building the builder of which desires a better roofing system initially. It is worth pointing out that metal decking which is utilized for metal buildings is generally configured with the high flute **40** being narrow and the low flute **42** being relatively wide which in the industry tends to be 12 to 16 inches in width. Because of the wide low flute it is desirable when installing a roof system thereon to utilize expanded polystyrene flute fillers **44** to effectively level the roof surface prior to installing upwardly adjacent layers. In this embodiment fillers **44** are effectively glued in place by slow rise foam **46** which has been sprayed over the deck **14** relatively uniformly in all locations but, of course, in accordance with the former teachings of this application, with particular attention paid to penetrations of the roof deck in order to prevent air leakage therethrough. Slow rise foam **46** is utilized in this regard in order to provide time for roof installers to position flute filler **44** prior to curing of material **46**. Subsequent to the installation of the flute filler **44** a relatively uniform coating of slow rise material **48** is sprayed over the entirety of the roof and insulation **50**, generally in board form, is set into slow rise material **48** prior to curing thereof in order to adhere the insulation **50** to the underlying roof component removing the need for metal fasteners for insulation **50** which would otherwise create thermal bridges through that insulation as has been evident in prior art roof structures.

Since it is well known in the art that insulation **50**, particularly if it is polystyrene or polyisocyanurate insulation cannot be left open to the elements therefore spray foam layer **52** is applied to the top surface **54** of insulation **50** to seal and protect the same. In one embodiment foam **52** would be about an inch thick. As in the foregoing embodiments the temporary roof structure is created without membrane **30** but membrane **30** will be desirably be installed upwardly adjacent the foam layer **52** when work on the building is completed.

Referring now to FIG. **5**, one of ordinary skill in the art will recognize some of the components of this figure are similar to those of FIG. **4** and therefore are numbered similarly in this embodiment. No insulation layer **50** is utilized but rather thicker sections of foam are utilized instead. In addition, a reinforcing layer **32** is installed. One method of installing this roof system starts as does the FIG. **4** embodiment with slow rise foam **46** adhering flute fillers **44** to low flutes **42** of the deck **14**. Immediately upwardly adjacent flute fillers **44**, a layer of foam **60** is applied which is, in one embodiment, about a half inch thick or thicker. It is again to be understood that this measurement is for exemplary and comparative purposes rather than for limiting purposes. More or less spray foam could be used at will. Reinforcing material **32**, which may be a mesh material such as a fiberglass, nylon, polyester or other similar property mesh as was the case in the foregoing embodiments, is positioned upwardly adjacent foam layer **60**. In the event that foam layer **60** utilizes slow rise foam, reinforcing material **32** is likely to be adhered to that foam. In the event that a fast rising/fast curing foam layer **60** is utilized it is possible that the reinforcing layer **32** may not adhere to layer **60**. Reinforcing layer **32** is mechanically fastened by fastener **62** through foam layer **60**, through flute filler **44** and through deck **14** to mechanically attach the roof system to the deck. While a mechanical fastener is utilized herein which raises concern about thermal bridging effects, it is noted that the fastener does not bridge all the way to the top surface of the roofing system and therefore the thermal bridging effects of the prior art are lessened or nullified in this embodiment. Subsequent to mechanically attaching the reinforcing material **32** to the roof deck an additional layer of foam material **64** is applied to a top surface of the mesh **32**. This may be of any thickness but in one embodiment will be about a half inch. As in the foregoing embodiments, once cured layer **64** the roof is temporarily water sealed and building construction activity across and thereon is permissible. Once work is done with respect to the building, the roofing membrane **30** is installed upwardly adjacent the top surface of foam layer **64** in a conventional way such as loose laid, fully adhered, mechanically attached, etc.

In the embodiment of FIG. **6**, a foam material **70** is applied to air seal a previously existing roofing assembly **71**. The roofing assembly **71** is upwardly adjacent a roof deck **72**, which may be a metal corrugated roof decking material that is fastened to an underlying support structure **74** by conventional means such as fasteners **76** or welding. The previously existing roofing assembly **71** may be a built up roof, which includes an insulation layer **78**, such as fiberboard, fiberglass, or gypsum board.

The roofing assembly **71** is uniformly (relatively) covered by the foam **70**, which may be a polyurethane foam, polyurea compound, or other material having similar properties and also including combinations of materials, including at least one of the foregoing materials. The foam **70** may be a slow curing foam or a fast curing foam, depending upon functionality desired by the installer, and may be applied to the roofing assembly **71** in multiple layers or a polyurea polymeric adhesion. If, as illustrated in FIG. **6**, reinforcing mesh **78** (which may comprise fiberglass, nylon, or polyester or other material having similar properties with respect to the purpose for which the reinforcing mesh **78** is added) is to be embedded in the foam **70**, the foam **70** may be applied in a first layer **80** and an additional layer **82**, with the first layer **80** being slow cure polyurethane type foam. Slow cure foam is desirable in this case because it allows adherence of the reinforcing mesh **78** to the uncured newly sprayed foam **70**. The additional layer **82** would likely be fast rise foam material, which will be utilized at this stage of the roof construction since it cures rapidly and allows workers to walk thereon very quickly.

It should be appreciated that the reinforcing mesh **78** discussed above may embedded at any level within the foam **70**. It should also be appreciated that at least one fastener **86**, extending at least partially through the foam material **70** and into the roof deck **72**, may also be used in conjunction with the foam material **70** and previously existing roofing assembly **71**. These fasteners **86** more securely fix the foam **70** with the roofing assembly **71**. As shown in the Figure, a waterproofing membrane **84** is also disposed upwardly of and adjacent to the foam **70**.

Each of the embodiments described hereinabove have substantial benefit with respect to the roofing industry. The first benefit is that the foam material utilized substantially enhances structural integrity of the roofing system. The second benefit is that for the metal-deck type systems the dew point on the building side surface of the metal deck has substantially changed such that condensation does not form and rust is substantially reduced. The third benefit is that a temporary roof is created which is rapid and relatively easy to install, prevents damage to underlying roof components and allows work to continue on the building without risk of damaging a roof waterproofing membrane. The fourth benefit is a substantially increased R-value of the roof system due to enhanced insulated properties of the foam material and due to the lack of thermal bridges existing within the structure.

While preferred embodiments of the invention have been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of illustration and not limitation.

What is claimed is:

1. A roof system comprising:

a previously existing roofing assembly

a foam material upwardly adjacent and in air sealing contact with said roofing assembly, said foam material being a rise and cure foam;

a layer of reinforcing mesh disposed upwardly of and in contact with said foam material;

an additional foam material of a different material than said foam material, wherein said additional foam material is disposed upwardly of and in contact with said reinforcing mesh, and wherein said additional foam material is disposed in contact with said foam material at said space around said perimeter of the roof system,

wherein said additional foam material is a rise and cure foam that rises and cures at a faster rate than said foam material;

wherein at least one of said foam material and said additional foam material fills a space around a perimeter of the roof system, and

a waterproof membrane upwardly adjacent of said additional foam material.

2. A roof system as claimed in claim **1**, wherein said previously existing roofing assembly is a built up roof.

3. A roof system as claimed in claim **1**, including at least one fastener extending at least partially through said additional foam material, said foam material, and said reinforcing mesh into said roof assembly.

4. A method for creating a roof system comprising:

air sealing a previously existing roofing assembly, said air sealing including

disposing a foam material upwardly adjacent and in air sealing contact with said roofing assembly, said foam material being a rise and cure foam;

disposing a layer of reinforcing mesh within upwardly of and in contact with said foam material;

disposing an additional foam material of a different material than said foam material upwardly of and in contact with said reinforcing mesh, wherein said additional foam material is a rise and cure foam that rises and cures at a faster rate than said foam material;

disposing said additional foam material to be in contact with said foam material at said space around said perimeter of the roof system, and

filling a space around a perimeter of the roof system with at least one of said foam material and said additional foam material.

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